Are biological corridors helping ecosystems to adapt to climate change in Costa Rica?

Bruno Locatelli[1], Pablo Imbach[2] and Yves Laumonier[1]

[1] CIRAD-CIFOR, Bogor, Indonesia
[2] CATIE, Turrialba, Costa Rica

For further information, please contact b.locatelli@cgiar.org

Introduction

As the distribution of biomes relates mainly to temperature and precipitation, it will be affected by climate change. The future distribution depends on the ability of plants to migrate, which may be reduced by landscape fragmentation. Biological corridors have been proposed for facilitating the adaptation of ecosystems to climate change. In Costa Rica, as protected areas are increasingly isolated, biological corridors are being progressively implemented (**Figure 1**).

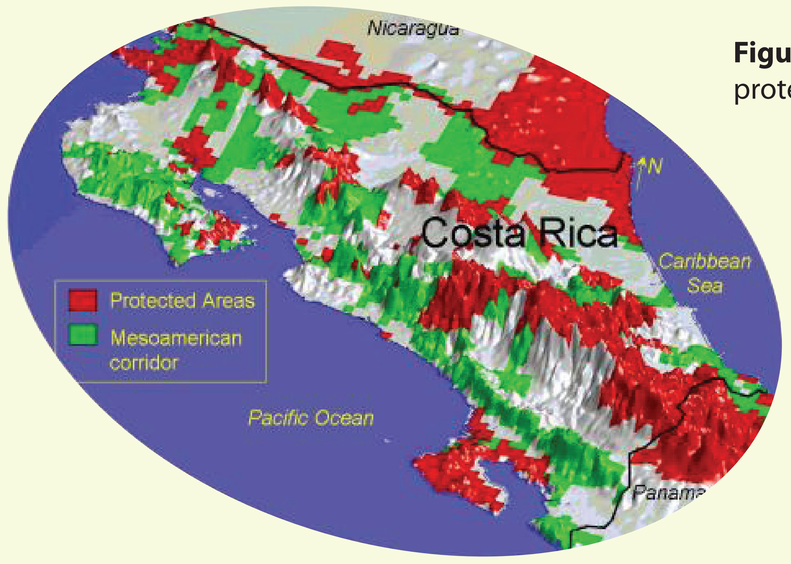

Figure 1. Corridors and protected areas in Costa Rica

Objective

Assessing the contribution of biological corridors (BC) to the adaptation of protected areas (PA) to climate change in Costa Rica

Methods and data

Model overview: We developed a spatial model with cellular automata, a resolution of 2 arc min (~5 km) and time steps of 10 years (from 1990 to 2050). Species can move between pixels when climate evolves, depending on their capacities and the landscape (**Figure 2**).

Vegetation representation: We used the Holdridge bioclimatic classification of life zones (**Figure 3**). Assumption: the vegetation adapted to each life zone is composed of 5 species with different migration capacities.

Data: We used altitude and climate data from WorldClim, land use, protected areas and corridors from CCAD & World Bank.

Model runs:

4 climate scenarios		X	4 migration representations		X	3 policy options	=	48 runs
HADCM3 and CCCMA climate models	A2 and B2 greenhouse gas emission scenarios		Species can migrate through contiguous or non contiguous pixels	Two sets of values for migration capacities of the 5 species (100, 250, 500, 1000 & 2000 m/yr and 50, 100, 250, 500 & 1000 m/yr)		- Enhanced corridors (natural vegetation in BC) - Status quo (current vegetation in BC) - Degraded corridors (no vegetation in BC)		

Analysis: Index of climate change impact = status of vegetation in PA in 2050, compared to two hypothetical scenarios (index = 0 for full natural vegetation in the country, i.e. unavoidable impact; index = 1 without migration, i.e. maximum impact).

Contributions of individual corridors: difference between the impacts of climate change on PA between a scenario with all BC and a scenario with all BC but one.

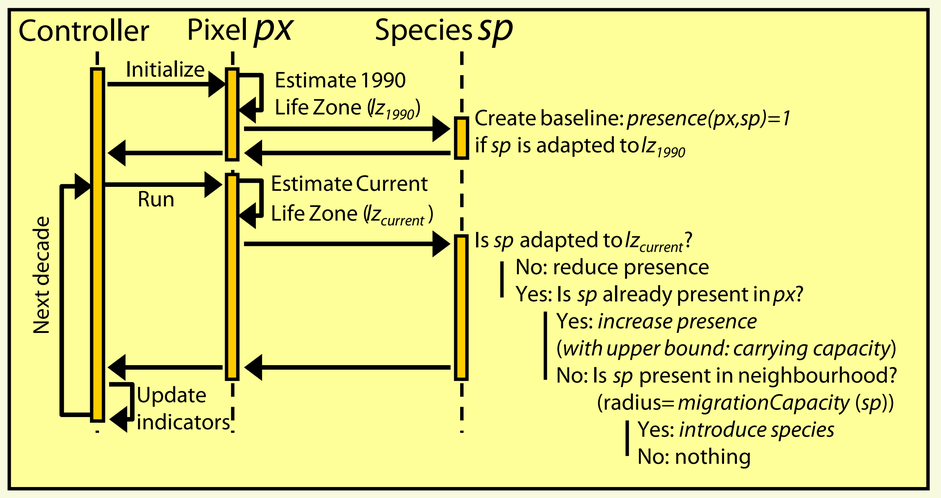

Figure 2. Algorithm

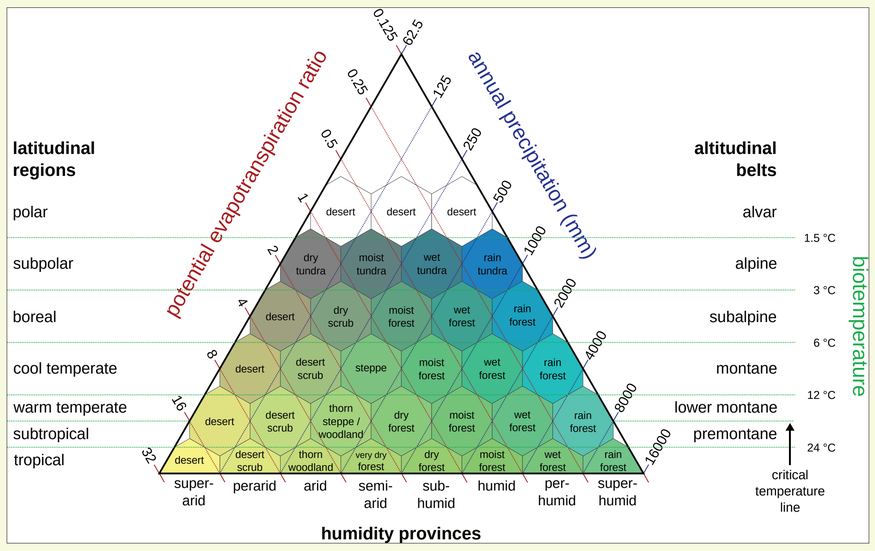

Figure 3. Holdridge life zones

Results and discussion

The enhancement of BC reduces the impacts of climate change on PA (**Figure 4**)

Analysis of sensitivity: results differ significantly with different climate scenarios ($p<0.05$) but not with different migration representations.

The PA most potentially impacted by climate change are located in the mountains and the dry northwest part of the country (results not shown).

The PA benefiting the most from BC are located in the Northwest, where PA are potentially highly impacted and poorly connected (**Figure 5**).

Corridors are benefiting less to PA in the southeast central mountains, because the PA are already connected.

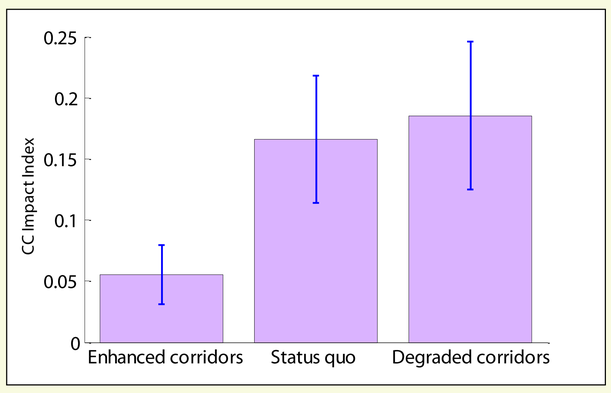

Figure 4. Impact of climate change on PA with different policies (bars represent the standard deviation of the results of the 16 runs for each policy option)

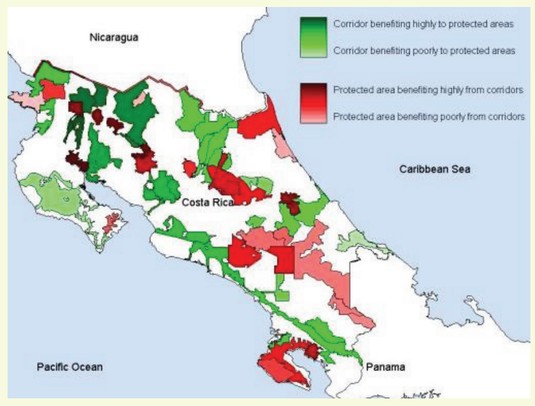

Figure 5. Contribution of individual corridors to the adaptation of protected areas

Conclusion

Corridors play an important role in facilitating the adaptation of protected areas in Costa Rica, especially altitudinal corridors and dry area corridors. This role is clear, even when uncertainties on climate and migration are taken into account. Climatic uncertainties have more influence on the results than uncertainties on migration processes. Several climate scenarios should therefore be considered when planning corridors for adaptation to climate change.

CATIE Solutions for environment and development / Soluciones para el ambiente y desarrollo
CIFOR
CIRAD
TroFCCA
Tropical Forests and Climate Change Adaptation